MEMBRANES CHEMICALS COMPATIBILITY
with effluent compounds and cleaning reagents

Compound	Affiliation (Group of chemicals)	Usage (cleaning/effluent compounds)	Compatibility	
			Yes	No
Acetic Acid	7		x	
Acetone	3			x
Acetonitrile	6			x
Aluminum sulfate	12		x	
AMDEA	Unknown abbreviation			
Ammonia	10		x	
Aniline	4			x
Anionic polymer	13		x	
Benzene	4			x
Butylacetate	3			x
Cationic polymer	13		x	
Citric Acid	7	Cleaning chemical, apply according to product data sheet	x	
DBNPA	Unknown abbreviation			
Dibutylphthalate	3, 4			x
Dichloromethane (DCM)	5			x
Dicyclohexylamine	4			x
N,N-Dimethylacetamide	6			x
N,N-Dimethylaniline	4			x
N,N-Dimethylformamide	6			x
Esters	3			x
Ethanol	1		x	
Ethylbenzene	4			x
Ferric chloride	12		x	
Ferric sulphate	12		x	
Formaline	3		x	
Gasoline	4		(x)	
Glycerin	1		x	

Compound	Affiliation (Group of chemicals)	Usage (cleaning/effluent compounds)	Compatibility	
			Yes	No
Halogenated Hydrocarbons	5			x
Hexamethyldisiloxane	13		x	
Hydrochloric Acid	11	Cleaning chemical, apply according to product data sheet		(x)
Hydrogen Peroxide	11	Cleaning chemical, to be applied according to concentrations given for NaOCl in product data sheet		(x)
Hypochlorite	11	See "sodium hypochlorite"		(x)
Isopropyl alcohol	1		x	
Kerosene	4		(x)	
Ketones	3			x
Lime [Kalk]	12		x	
Metals	14		x	
Methanol	1		x	
N-Methylpyrrolidinone	6			x
Mono Ethylene Glycol (MEG)	1		x	
Nitric Acid	9	Cleaning chemical applied at strong CaSO4 or MGSO4 fouling, pH according to product data sheet	x	
Oxalic Acid	7	Cleaning chemical for strong ferric or manganese fouling, concentration for cleaning up to 5%	x	
Ozone	11			x
Phenol	4		x	

Compound	Affiliation (Group of chemicals)	Usage (cleaning/effluent compounds)	Compatibility	
			Yes	No
Phosphoric Acid	9	Cleaning chemical sometimes applied in food applications, pH according to product data sheet	x	
Potassium Hydroxide	10		x	
Seawater	14		x	
Silicone	13		x	
Soda	12		x	
Sodium Hydroxide	10	Cleaning chemical, pH according to product data sheet	x	
Sodium Hypochlorite	11	Cleaning chemical, concentration according to product data sheet		(x)
Sulfolane	4			x
Sulfamic Acid	9		x	
Sulphuric Acid	9	Cleaning chemical, pH according to product manual		(x)
Tetrahyrofuran	2			x
Toluene	4			x
Triethylamine	8			x
Ultrapure Water	14		x	
Xylene	4			x

Groups of Chemicals

1. Alcohols
2. Ether
3. Ester, Aldehydes, Ketones
4. Saturated and non-saturated Hydrocarbons
5. Chlorinated hydrocarbons
6. Aprotic, polar organic solvents
7. Organic acids
8. Organic alkaline solutions
9. Inorganic acids
10. Inorganic alkaline solutions
11. Oxidative compounds
12. Inorganic salts
13. Polymers
14. Others

No 1. Alcohols
Low molecular weight, simple alcohols (Methanol, Ethanol, Propanol ...) cause swelling (moisture expansion) of the membrane material, but don't chemically deteriorate the membrane.
Higher molecular weight alcohols (such as Glycol, Glycerine) cause almost no swelling and don't chemically deteriorate the membrane.

No 2. Ether
Low molecular weight Ethers cause intense swelling (moisture expansion) and deteriorate the membrane (embrittlement).
Low concentration cause slow embrittlement, higher concentrations cause rapid embrittlement.
Higher molecular weight ethers, (especially Glycole and Glycolether) deteriorate the membrane. In higher concentration, the membrane matrix is getting dissolved; in lower concentrations, the membrane matrix is weakened and pores will get larger.

No 3. Ester, Aldehydes, Ketones
Low molecular weight aliphatic Esters deteriorate the membrane quickly in higher concentrations. In low concentrations, they cause slow embrittlement and thus ageing of the membranes.
Ketones (such as Acetone) cause swelling (moisture expansion) of the membrane material, and in high concentrations, they cause embrittlement and thus ageing of the membranes.

No 4. Saturated and non-saturated Hydrocarbons
No chemical deterioration, but heavy blocking of the membrane pores through adhesion of the chemicals to the membrane polymers (on the surface and inside the pores / inside the membrane matrix). This blocking is not easily reversible with chemical cleanings.
There may be synergy-effects with hydrocarbons and other organic chemicals which may cause a significant lowering of the risk potential.

No 5. Chlorinated hydrocarbons
similar to the non-chlorinated hydrocarbons, they may adhere to the membrane matrix (either on the surface or within the pores); but in addition, they have an effect which is either weakening the membrane or even deteriorating (Di-chlorethane).

Some chlorinated hydrocarbons are solvents for polymers.
Generally, halogenated hydrocarbons are more deteriorating as non-halogenated hydrocarbons and aromatic hydrocarbons are more deteriorating than aliphatic hydrocarbons.

No. 6 Aprotic polar organic solvents
cause swelling (moisture expansion) of the membrane material; with higher concentrations, there is an additional deteriorating effect (weakening or even dissolving the membrane matrix).

No. 7. organic acids
low molecular weight acids (such as formic acid or acetic acid) cause swelling (moisture expansion) of the membrane material, in higher concentrations with an additional deteriorating effect (dissolving the membrane matrix).

No. 8. Organic alkaline solutions
In higher concentrations, they may deteriorate the membrane material and weaken the membrane matrix (Triethylamine)

No. 9. Inorganic acids
Pure nitric acid and sulphuric acid are known to be a solvent for polymers and dissolve the membrane matrix.
The known strong acids deteriorate the membrane matrix. The deterioration effect increases with concentration, contact time and temperature.

No. 10. Inorganic alkaline solutions
Caustic soda is tolerated to a high extent; caustic potash in higher concentrations (>40%) causes more problems, ammoniac can not be tolerated.

No. 11. Oxidative compounds (NaOCl, H_2O_2, O_3, peracetic acid)
In higher concentrations, all oxidative compounds deteriorate the membrane and cause embrittlement by degradation of the carbon-chains of the polymer-molecules.
Oxidative compounds are destructive in **any** concentration.

> However the effect of the oxidative compounds (NaOCl, H_2O_2) have been largely investigated as these are used for regular chemical cleaning of the membranes.
> The typically used oxidative compounds (NaOCl and H_2O_2) can be tolerated with up to 500.000 ppm*h following the KMS PURON ® operating and maintenance instructions.

No. 12. Inorganic salts
Direct negative effects are not known; but being dissolved in water, the ions may significantly shift the pH towards alkaline values (Na_2CO_3, „Soda“) or towards acid values (NH4Cl „ammonium chloride“). As long as the normal pH operating range is not exceeded (5 - 10), there is no deteriorating chemical effect on the membrane material.
Salts with low solubility on water (such as $CaCO_3$, Lime) can precipitate in the (aerated) environment around the membrane.
When precipitating directly on the membrane surface, they may create lime scaling (which is reversible to a certain extent with acid cleanings) or, when forming (sharp edged) crystals, these may mechanically abrade the membrane surface.

No. 13. Polymers
Chemical deterioration is not known.
Polymers may however adhere to the membrane material and block the membrane pores mechanically; which - in the case of Silicones - may be irreversible.

No. 14. Others
Metals, glass splinters, sand and grit are abrasive

Important note:

The present document describes the effect of single chemicals being dissolved in water onto the membrane material and matrix.

In the context of a wastewater treatment system using mechanical pre-treatment (including oil- fat and grease removal) and a membrane bioreactor system (MBR); the membranes, which are at the end of the process are often not coming into contact with the chemicals being eventually found at the inlet of the plant.

Various effects need to be taken into account by the OEM / by the consultant; for example:

- An aerated grit chamber with combined oil- fat and grease removal will remove most of the non-soluble hydrocarbons.
- Acids and alkaline may neutralize each other and the acid buffer capacity of a huge bioreactor with activated sludge is considerably high, so that the pH is generally stable around 7 - 8,5. This also reduces the potential of precipitation of inorganic salts in the system.
- Oxidative compounds get exhausted oxidizing the COD (bacteria) in the activated sludge before coming into contact with membranes.
- Dissolved hydrocarbons will get biologically degraded in the bioreactor to a certain extent.
- Hydrocarbons and nutrients are getting incorporated into the bacteria cell mass.
- Adhesion of some chemical compounds (macromolecules) to the structure of sludge flocks may avoid that these compounds enter into direct contact with the membrane, but they are withdrawn out of the system with the excess sludge.

All these effects (and many more) make the system much more stable and membranes being used within an MBR system much less vulnerable than a membrane alone which is used for direct filtration.

It is responsibility of the system designer and of the system builder to judge these effects and evaluate in how far the different chemical compounds may get through the system to get a direct contact with the membrane where they finally might have their deteriorating effect.

****